Science
Grade-Level Expectations: Physics
(Recommended for Grades 11–12)

Science as Inquiry

The Abilities Necessary to Do Scientific Inquiry

1. Write a testable question or hypothesis when given a topic (SI-H-A1)
2. Describe how investigations can be observation, description, literature survey, classification, or experimentation (SI-H-A2)
3. Plan and record step-by-step procedures for a valid investigation, select equipment and materials, and identify variables and controls (SI-H-A2)
4. Conduct an investigation that includes multiple trials and record, organize, and display data appropriately (SI-H-A2)
5. Utilize mathematics, organizational tools, and graphing skills to solve problems (SI-H-A3)
6. Use technology when appropriate to enhance laboratory investigations and presentations of findings (SI-H-A3)
7. Choose appropriate models to explain scientific knowledge or experimental results (e.g., objects, mathematical relationships, plans, schemes, examples, role-playing, computer simulations) (SI-H-A4)
8. Give an example of how new scientific data can cause an existing scientific explanation to be supported, revised, or rejected (SI-H-A5)
9. Write and defend a conclusion based on logical analysis of experimental data (SI-H-A6) (SI-H-A2)
10. Given a description of an experiment, identify appropriate safety measures (SI-H-A7)

Understanding Scientific Inquiry

11. Evaluate selected theories based on supporting scientific evidence (SI-H-B1)
12. Cite evidence that scientific investigations are conducted for many different reasons (SI-H-B2)
13. Identify scientific evidence that has caused modifications in previously accepted theories (SI-H-B2)
14. Cite examples of scientific advances and emerging technologies and how they affect society (e.g., MRI, DNA in forensics) (SI-H-B3)
15. Analyze the conclusion from an investigation by using data to determine its validity (SI-H-B4)
16. Use the following rules of evidence to examine experimental results:
    (a) Can an expert's technique or theory be tested, has it been tested, or is it simply a subjective, conclusive approach that cannot be reasonably assessed for reliability?
    (b) Has the technique or theory been subjected to peer review and publication?
    (c) What is the known or potential rate of error of the technique or theory when applied?
    (d) Were standards and controls applied and maintained?
    (e) Has the technique or theory been generally accepted in the scientific community? (SI-H-B5) (SI-H-B1) (SI-H-B4)

Physical Science

Measurement and Symbolic Representation

1. Measure and determine the physical quantities of an object or unknown sample using correct prefixes and metric system units (e.g., mass, charge, pressure, volume, temperature, density) (PS-H-A1)
2. Determine and record measurements correctly using significant digits and scientific notation (PS-H-A1)

3. Determine accuracy and precision of measured data (PS-H-A1)
4. Perform dimensional analysis to verify problem set-up (PS-H-A1)
5. Use trigonometric functions to make indirect measurements (PS-H-A1)

Forces and Motion

6. Explain the role of strong nuclear forces and why they are the strongest of all forces (PS-H-E1)
7. Relate gravitational force to mass and distance (PS-H-E1)
8. Compare and calculate electrostatic forces acting within and between atoms to the gravitational forces acting between atoms (PS-H-E1)
9. Describe and measure motion in terms of position, displacement time, and the derived quantities of velocity and acceleration (PS-H-E2)
10. Determine constant velocity and uniform acceleration mathematically and graphically (PS-H-E2)
11. Plot and interpret displacement-time and velocity-time graphs and explain how these two types of graphs are interrelated (PS-H-E2)
12. Model scalar and vector quantities (PS-H-E2)
13. Solve for missing variables in kinematic equations relating to actual situations (PS-H-E2)
14. Add and resolve vectors graphically and mathematically to determine resultant/equilibrant of concurrent force vectors (PS-H-E3)
15. Calculate centripetal force and acceleration in circular motion (PS-H-E3)
16. Analyze circular motion to solve problems relating to angular velocity, acceleration, momentum, and torque (PS-H-E3)
17. Analyze simple harmonic motion (PS-H-E3)
18. Demonstrate the independence of perpendicular components in projectile motion and predict the optimum angles and velocities of projectiles (PS-H-E3)

Energy

19. Explain quantitatively the conversion between kinetic and potential energy for objects in motion (e.g., roller coaster, pendulum) (PS-H-F1)
20. Calculate the mechanical advantage and efficiency of simple machines and explain the loss of efficiency using the dynamics of the machines (PS-H-F1)
21. Explain and calculate the conversion of one form of energy to another (e.g., chemical to thermal, thermal to mechanical, magnetic to electrical) (PS-H-F1)
22. Analyze energy transformations using the law of conservation of energy (PS-H-F2)
23. Apply the law of conservation of momentum to collisions in one and two dimensions, including angular momentum (PS-H-F2)
24. Apply the concept of momentum to actual situations with different masses and velocities (PS-H-F2)

Interactions of Energy and Matter

25. Determine the relationships among amplitude, wavelength, frequency, period, and velocity in different media (PS-H-G1)
26. Evaluate how different media affect the properties of reflection, refraction, diffraction, polarization, and interference (PS-H-G1)
27. Investigate and construct diagrams to illustrate the laws of reflection and refraction (PS-H-G1)
28. Draw constructive and destructive interference patterns and explain how the principle of superposition applies to wave propagation (PS-H-G1)

29. Describe observed electrostatic phenomena, calculate Coulomb's law, and test charge pole, electric field, and magnetic field (PS-H-G2)
30. Construct basic electric circuits and solve problems involving voltage, current, resistance, power, and energy (PS-H-G2)
31. Describe the relationship of electricity, magnetism, and inductance as aspects of a single electromagnetic force (PS-H-G2)
32. Compare properties of electromagnetic and mechanical waves (PS-H-G3)
33. Solve problems related to sound and light in different media (PS-H-G3)
34. Compare the properties of the electromagnetic spectrum as a wave and as a particle (PS-H-G3)
35. Analyze the Doppler effect of a moving wave source (PS-H-G3)